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Overview of differential VLBI observations of lunar orbiters in SELENE (Kaguya) for precise orbit determination and lunar gravity field study

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Abstract

The Japanese lunar explorer SELENE (Kaguya), which was launched on September 14th, 2007, was the target of VLBI observations over the period November 2007 to June 2009. These observations were made in order to improve the lunar gravity field model, in particular the lower degree coefficients and the model near the limb. Differential VLBI Radio sources, called VRAD instruments, were on-board the subsatellites, Rstar (Okina) and Vstar (Ouna), and the radio signals were observed by the Japanese VERA (VLBI Exploration of Radio Astrometry) network, and an international VLBI network. Multi-frequency and same-beam VLBI techniques were utilized and were essential aspects of the successful observing program. Multi-frequency VLBI was employed in order to improve the accuracy of the orbit determination obtained from the phase delay from the narrow-band satellite signals, while the same-beam VLBI method was used to resolve the cycle ambiguity which is inherent in the multi-frequency VLBI method. The observations were made at three S-band frequencies (2212, 2218 and 2287 MHz), and one X-band frequency (8456 MHz). We have succeeded in correlating the recorded signals from Okina/Ouna, and we obtained phase delays with an accuracy of several pico-seconds at S-band.

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Keywords

Gravity field, Lunar explorer, Orbit determination, VLBI